

Does Tougher Import Competition Foster Product Quality Upgrading?

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Abstract

Over the past two decades, globalization, and more specifically the increased exposure to competition from low-price producers in China and India, has created a new economic environment for other emerging economies. The most advantageous way for manufacturing firms in those economies to position themselves in domestic and international markets is to offer upgraded and differentiated rather than “mundane” labor-intensive products. This paper investigates whether increased competitive pressure from imports forces firms to improve the quality of their products. The econometric analysis relies on a rich dataset of Chilean manufacturing plants and their products. Product

quality is measured with unit values (average prices) and industry-level transport costs are used as an exogenous measure of import competition. The authors find a positive and robust effect of import competition on product quality. This effect is found to be particularly strong for non-exporting plants. The results also show that increased import competition from less advanced economies is the major cause for the positive impact on quality upgrading. The overall evidence points to the benefits of trade openness for product innovation but demonstrates at the same time that competitive pressure alone will not enable local plants to catch up with leading world producers.

This paper—a product of the Trade Team, Development Research Group—is part of a larger effort in the department to understand the links between trade costs, competition, and innovation. Policy Research Working Papers are also posted on the Web at <http://econ.worldbank.org>. The author may be contacted at afernandes@worldbank.org.

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1. Introduction

The acceleration in globalization witnessed over the last two decades and the corresponding increased exposure to competition from low-price producers in China and India have created a new economic environment for emerging economies (World Bank, 2006; OECD-WEF, 2008). Since production costs - especially those that are wage-related - cannot be infinitely reduced, the main way for manufacturing firms in those economies to position themselves in domestic and international markets is to focus on offering upgraded and differentiated rather than “mundane” labor-intensive products (Moreira, 2007). Pietrobelli and Rabellotti (2006) argue that such upgrading will provide the “high road” to competitiveness offering higher revenues and wages in contrast to the “low road” which would require price reductions squeezing revenues. Many factors can facilitate taking on the “high road”, one of them is the competitive pressure from abroad which may force firms to improve their products to stay in business. In this paper, we provide a rigorous empirical foundation to this hypothesis by examining the following question: Does increased exposure to import competition foster firm product quality upgrading?

Innovation plays a crucial role in growth and welfare (Grossman and Helpman, 1991; Aghion and Howitt, 1998). However, the effects of competition on innovation are the object of some theoretical controversy and the empirical evidence is not always clear-cut as discussed below. Our study fills a gap in the literature by examining a potentially important determinant of incremental innovation reflected in product quality upgrading: import competition.¹ In an emerging economy context it is all the more relevant to focus on such upgrading since most firms lag behind the world’s technology frontier so radical innovation outcomes are less forthcoming.

While the idea of linking import competition to product quality upgrading is appealing, its empirical implementation faces two challenges. The first challenge concerns the measurement of

¹ We follow Pietrobelli and Rabellotti (2006) in equating product quality upgrading with innovation “to increase value-added”.

product quality. To address it, we exploit a new dataset including rich information from census data on all the products manufactured by all Chilean plants during the 1997-2003 period. We follow the empirical trade literature and use unit values (prices) of products to measure their unobserved quality or sophistication.² The second challenge concerns the difficulty in identifying causal effects of import competition on quality upgrading as upgrading can itself affect whether and how much foreign competitors choose to export to the domestic market. To address it, we rely on an effective trade barrier measure - transport costs - which capture differences in import competition across industries that are exogenous to quality upgrading.

Our econometric approach exploits variation in transport costs across 4-digit industries and over time and consists of regressions of product unit values on a lagged measure of transport costs, a set of plant and industry control variables, as well as product, plant, year, and industry-year fixed effects. Importantly, our specifications identify impacts by establishing comparisons of unit values across plants *within* product categories. No attempt is made to distinguish higher-quality from lower-quality products since differences across products in units of measurement and other characteristics preclude the direct comparability of their unit values.

Our main finding is that import competition has a positive and significant impact on plant-level product quality upgrading. The magnitude of the estimated impact increases as our sample is progressively restricted to include all plants but only the products that they neither start producing nor discontinue producing during the sample period (continued products) and then to include only the plants in the sample during the entire period of analysis (continuing plants) and their continued products. This difference in magnitudes suggests that products with less

² Iacovone and Javorcik (2008), Kugler and Verhoogen (2008), and Lelarge and Nefussi (2008) use data on unit values of domestic or exported products to proxy for product or export quality at the plant level, while Kiyota (2008) and Schott (2008) use data on unit values of exports to proxy for export quality at the country level.

upgrading potential are likely to be discontinued by plants and new products are also less subject to upgrading as a result of import competition after their initial introduction.

Our estimates show that it is mainly increased import competition from less advanced economies that leads to the average positive impact of import competition on quality upgrading. This finding suggests that while increasing the sophistication of products is a distinct option that Chilean plants use to escape competition from less advanced economies, competition from more advanced economies does not engender the same response. Focusing on the differential impacts of tougher import competition across plants, we find that domestic-owned plants that do not export their products exhibit the strongest response in terms of quality upgrading. This is likely the case because the other plants are already exposed to international competition through other channels. We also show that increased import competition provides a significantly larger boost to the quality of products sold only in the domestic market than to the quality of products that are also (or exclusively) exported. Finally, we provide evidence that import competition is associated with a wider divergence in quality within product categories, which may suggest the presence of heterogeneous impacts of competition on plants with different productivity.

We successfully submit our results to a variety of tests. Our results are robust to the use of multiple outlier criteria and to the inclusion of additional or alternative control variables. Our findings are also maintained if different lags of the transport cost measure or alternative transport cost measures are used, suggesting that endogeneity problems are not a concern. A different concern about our results arising from the use of plant product prices as our outcome of interest is that the imports-as-market-discipline-hypothesis predicts a negative effect of import competition on prices and price-cost margins (Levinsohn, 1993; Melitz and Ottaviano, 2008). Since radical trade liberalization in Chile occurred in the early 1980s, we would not expect the pro-competitive price-lowering effects (the aforementioned “low road”) as a reaction to imports to still play a

major role during our sample period. Indeed, we are able to dismiss those concerns based on our estimation of the link between transport costs and price-cost margins of Chilean plants following the widely used methodology proposed by Roeger (1995). Finally, while the use of unit values to signal product quality is well-founded in the industrial organization and the trade literatures, we provide explicit evidence confirming that our estimated increases in unit values due to tougher import competition are indeed picking up improvements in product quality.

Our paper relates to the debates in two strands of the literature. First, theoretical and empirical studies on product market competition and innovation are unclear about the sign of that relationship (Ahn, 2002). In a seminal contribution, Schumpeter (1942) argues that producers facing less competition are best placed to innovate since getting adequate returns for one's innovation requires some form of temporary monopoly power. In contrast, strong competition may foster innovation as producers need to escape their innovating peers to stay in business. Aghion et al. (2005, 2006) predict and show evidence of an inverse U-shaped relationship between competition and innovation based on a model which allows for counteracting 'escape competition' effects as well as 'Schumpeterian' effects of competition on innovation. Gorodnichenko et al. (2008), however, find no support for the inverse U-shaped relationship. Second, the theoretical literature on within-plant margins of adjustment to increased import competition is ambiguous about the incentives for plants to invest in productivity-enhancing technology and innovate.³ In Goh (2000) import competition increases these incentives by reducing the opportunity cost of technological effort and in Thoenig and Verdier (2003) it results in defensive skill-intensive innovations by plants desiring to reduce future threats of imitation or leapfrogging by competitors. In contrast, Rodrik (1992) argues that by reducing the plant's

³ See Tybout (2000) for a survey of the literature.

market share, import competition may actually decrease its incentives to innovate, reviving the arguments of Schumpeter (1942).

To the best of our knowledge, empirical studies examining the effects of import competition on plant-level innovation outcomes are rare and those available differ in important aspects from ours. Bertschek (1995) and Baldwin and Gu (2004) examine the effect of import competition measuring German and Canadian plants' involvement in product upgrading or innovation by an affirmative answer to the question: 'Did you introduce new or significantly improved goods'.⁴ Lelarge and Nefussi (2008) study the link between import competition from low-wage countries and French plants' research and development (R&D) spending and the effect of the latter on exported products' unit values, in the absence of information on domestically sold products.

Our study's contributions to the literature are four-fold. First, ours is the first paper to examine the impact of import competition on incremental rather than radical R&D-intensive innovation at the plant level for an emerging economy. Indeed, this is the type of innovation that is more prevalent in emerging economies where producers often improve upon products imported from developed countries. Second, we measure incremental innovation using direct quantitative information on product prices instead of relying on subjective perception-based measures of product upgrading as in previous studies. Third, we analyze the effects of import competition on quality upgrading for the universe of Chilean manufacturing products whereas most previous studies focus on exported products. This feature of the analysis is particularly important given that 86 percent of the products manufactured by Chilean plants are sold only in domestic markets. Furthermore, exported products may differ in many respects from domestically sold products, thus estimates obtained focusing exclusively on the former may be biased. Fourth, our identification of the effects of import competition on product quality relies on the use of a

⁴ Alvarez and Robertson (2004) use a similar question to relate innovation outcomes for Chilean and Mexican plants to alternative dimensions of openness: foreign direct investment and exports.

measure of transport costs that separates freight costs from insurance costs and thus improves upon that used by Bernard et al. (2006a) for U.S. industries and can confidently be considered exogenous to quality upgrading.

Our findings suggest that increased exposure to import competition, including that from China and India, may be beneficial by encouraging producers to follow the “high road” to competitiveness (Pietrobelli and Rabellotti, 2006). Taking into account the evidence provided by Iacovone and Javorcik (2008) that Mexican plants invest in product quality upgrading before they export, our findings suggest that over time plants - including those with no export experience - may be able to progressively target more sophisticated export markets. However, our evidence also suggests that import competition may be insufficient to enable quality upgrading where the technology gap between foreign competitors and local producers is high. Other policy tools will be necessary to encourage more radical innovation in products.

The remainder of the paper proceeds as follows. Section 2 describes the data and Section 3 presents the empirical specification. Section 4 discusses our main results, robustness tests, evidence of quality upgrading, and the imports-as-market-discipline hypothesis. Section 5 examines the differential impacts of import competition by type of exporting country and by type of plant and product. Section 6 concludes.

2. Data

2.1. Plant Unit Values and Other Information

In our analysis, we use a dataset with information on products at the plant level from 1997 to 2003 that is merged with the annual manufacturing census of Chilean plants with more than 10 employees (ENIA). Both datasets are provided and collected by the Chilean National Statistical Office. The products dataset includes information for each plant and year on the physical quantity

sold and the sales value of each of 2,018 products at the 7-digit ISIC level (revision 2). Appendix Table 1 provides some examples of 7-digit ISIC level categories to illustrate the level of detail of the products. The ENIA census described in detail in Fernandes and Paunov (2008) is an unbalanced panel of plants capturing entry and exit that includes information on basic plant characteristics such as employment or ownership, and on accounting variables such as sales.

For each product $p7$ of plant i in year t we construct a unit value as $UV_{it}^{p7} = S_{it}^{p7} / Q_{it}^{p7}$, where S is the value of sales and Q is the physical quantity sold. A unit value measures the average price charged by a plant for each product in a year. We assume that an increase in unit values proxies for plant product quality upgrading. Our dataset reports the physical quantities of the 2,018 products in 20 different measurement units, some of which are shown in Appendix Table 1. The unit values for products measured in different units (e.g., price per kilogram, price per liter) are not comparable. To obtain our final estimating sample, we address two issues on the measurement units of the products' physical quantities: (i) some plants do not report the measurement unit of their products' quantity, and (ii) some plants report their products' quantity in a different unit than the unit in which the majority of plants report product quantities. The unit values of both types of plants cannot be compared to those of other plants producing the same 7-digit product and are thus excluded from the final sample. Further, to eliminate potential outliers we exclude the top and bottom 5% of the distribution of unit values for any 7-digit product. Appendix 2 describes further the cleaning procedures used for the products dataset and some tests performed to assess the goodness of the data. Our final sample combining the products dataset with the ENIA census includes 55,294 plant-year-product observations with the average number of products manufactured per plant being 2.3. Navarro (2008) shows that many stylized facts

based on the Chilean products dataset are similar to those obtained for a U.S. products dataset by Bernard et al. (2006b) and an Indian products dataset by Goldberg et al. (2008).⁵

Table 1 shows average coefficients of variation in unit values for selected 4-digit industries. The statistics show a substantial degree of heterogeneity in unit values across plants and point to some interesting differences across industries. Industries with homogeneous products and thus less scope for quality differences such as cement or petroleum refineries are characterized by low average coefficients of variation. However, industries where quality is expected to play a more important role such as electrical machinery, motorcycles, and professional equipment are characterized by higher coefficients of variation.

2.2. Transport Costs

Our measure of transport costs is based on detailed information provided by the Latin American Integration Association (ALADI) on freight costs excluding insurance costs and the free on board customs value (fob) of Chilean imports for each 8-digit Harmonized System (HS) code, exporting country, and year from 1997 to 2003. First, we compute for 8-digit HS code i from exporting country c in year t freight rates as the ratio of freight costs ($freight_{ict}$) to the fob value of imports (fob_{ict}): $TC_{ict} = freight_{ict} / fob_{ict}$. Second, we aggregate these freight rates from the 8-digit HS code, exporting country, and year level to the 4-digit ISIC (revision 2) and year level using (i) a concordance between 8-digit HS and 4-digit ISIC codes and (ii) weights given by Chile's 8-digit HS fob imports from each exporting country and year as a ratio to Chile's total imports in the corresponding 4-digit ISIC code in that year. Appendix 2 provides more details on the construction of the freight costs measure hereafter referred to as 'transport costs measure'.

⁵ For example, the average shares of the most important product, the second most important product, and so on, in total sales of Chilean multi-product plants are strikingly similar to those of U.S. and Indian multi-product plants.

Table 2 illustrates the substantial variation in our transport costs measure over time and across a selection of 4-digit industries. Since some countries may not export a product to Chile due to prohibitive transport costs, our measure is a lower bound for transport costs accounting only for those of exports that actually occur (Hummels, 2001). However, as this feature of our measure is common to all products, it does not impair our analysis which focuses on differences in the relative, rather than the absolute, magnitude of transport costs across industries and time.

Transport costs proxy adequately for the exposure to import competition of plants in Chilean industries during the sample period for four reasons. First, export choices are to some extent driven by freight costs. For example, within disaggregate product categories, exporters with the lowest freight rates are shown to have the largest import shares based on data for the U.S., New Zealand, Argentina, Brazil, Chile, Paraguay, and Uruguay (Hummels, 2001). Second, transport costs can play an important role in “altering patterns of trade across goods and partners” due to their size and variability across trade partners (Hummels et al., 2008). Third, transport costs represent currently a greater share of trade costs than tariffs for most countries including Chile (Anderson and Wincoop, 2004).⁶ Fourth, our transport costs measure excludes insurance costs and, therefore, does not suffer from the related concerns of endogeneity.

Finally, note that our transport costs measure is obtained at the 4-digit ISIC revision 2 level. A more aggregate measure may not adequately capture the degree of import competition faced by plants. For example, 3-digit industry 311, food manufacturing, includes 4-digit industries ranging from fruit and vegetable canning to bakery. If we considered a transport costs measure at the 3-digit level, an increase in imported bakery products would erroneously suggest

⁶ The most usual measure of trade barriers - tariffs - is not informative in the Chilean context due to the uniform tariff structure across industries in place since the 1980s’ trade liberalization (Chumacero et al., 2004). Chile’s entry into preferential trade agreements with various countries and regions since the 1990s introduced a complex set of product- and country-specific exceptions to that uniform tariff structure that could provide useful variation for our analysis. However, such exceptions are subject to political economy pressures and likely to be endogenous to product quality in an industry.

that fruit and vegetable canning products also faced stronger import competition, when such products are not exactly substitutes. Certainly, one could argue that measuring import competition at the 4-digit level for bakery products (ISIC 3117) is still too aggregate. An import competition measure at the 4-digit level implies that increased imports of cookie products strengthen the competition faced by cake products too. Cake products may indeed be challenged by imports of cookie products because consumers may decide to substitute cake for cookie products. If competition was measured at a more disaggregate level - i.e., distinguishing cake from cookie products - then one might wrongly ignore that cross-effect. Hence, we consider 4-digit to be an adequate level at which to measure the degree of import competition as it accounts for a reasonable degree of substitutability across products.

3. Empirical Framework

To examine the impact of import competition on product quality, we need to account for the fact that 49 percent of Chilean plants manufacture multiple 7-digit products. Among these multi-product plants in any given year, 55 percent manufacture products within a single 4-digit industry whereas the rest manufacture products across at least two different 4-digit industries.⁷ As mentioned in Section 2.2, transport costs are measured at the 4-digit level. Thus, plants manufacturing 7-digit products in various 4-digit industries face a different degree of import competition in each of the 4-digit industries to which their products belong. The specification which allows us to examine quality upgrading responses to changes in the transport costs faced by each of the plant's products is given by:

$$\log UV_{it}^{p7} = \bar{\beta}_{TC} * TC_{it-1}^{k4} + \gamma * X_{it} + I^{p7} + I_t + I^{m3} * I_t + f_i + \varepsilon_{it}^{p7}, \quad (1)$$

⁷ Thus, in any given year about 78% of Chilean plants manufacture products within a single 4-digit industry.

where $\log UV_{it}^{p7}$ is the log of the unit value for 7-digit product $p7$ manufactured by plant i in year t , TC_{it-1}^{k4} are transport costs for 4-digit industry $k4$ to which the plant's product $p7$ belongs, X_{it} is a vector of controls to be specified below, I^{p7} are 7-digit product fixed effects, I_t are year fixed effects, $I^{m3} * I_t$ are 3-digit industry $m3$ -year fixed effects, f_i are plant fixed effects, and ε_{it}^{p7} is an independent and identically distributed (i.i.d.) residual.

We now discuss various econometric issues associated with the estimation of Equation (1). First, there is a possibility of reverse causality as product quality may affect import competition. Improvements in product quality in Chile may encourage the opening of its economy to further trade (e.g., by reducing lobbying pressures against openness) and result in tougher import competition. This issue does not concern us, though, since our measures capture 'external' transport costs incurred by imports from the exporting country until the arrival to Chilean ports and thus are not affected by Chilean trade policy decisions. Moreover, even if Chilean policy-makers attempted to reduce trade-related insurance costs or to improve the quality of domestic ports, those actions would not be captured by our measure of transport costs which excludes insurance costs. This advantage of our measure relative to that of Bernard et al. (2006a) is particularly relevant as insurance costs increase with the value - and likely the quality - of an exported product (Hummels et al., 2008).

Nevertheless, there are two possible ways in which product quality could affect transport costs. The first possibility is that if certain countries' producers stopped exporting to Chile due to improved domestic product quality, our measure of transport costs could be affected since those countries no longer enter the transport costs' calculation. If these countries used to export high-quality products to Chile, then the import competition faced by Chilean plants in these 4-digit industries would be effectively reduced. However, the new measure of transport costs would only

increase, reflecting this decline in competition, if those countries also had low transport costs. It is likely that it would be producers in countries exporting smaller quantities to Chile that would stop exporting and that exporting smaller quantities would be linked to higher transport costs. Thus, measured transport costs could decrease as a result of quality upgrading. This issue is relevant for our analysis to the extent that only half of Chile's import relationships at the country-4-digit industry level last the entire sample period.⁸ However, since our measure is a weighted average of transport costs across all countries, the exclusion of a country is unlikely to affect it unless it is one of Chile's largest trading partners. Our data shows that few large trading partners stop exporting any 4-digit categories to Chile during the sample period.⁹ Nonetheless, we consider this issue in our robustness checks in Section 4.2 and find that our results are not driven by this potential reverse causality channel. The second possibility is that improvements in product quality in Chile could motivate producers in certain countries to export smaller quantities to Chile. This would result in higher freight rates if exporters no longer benefit from economies of scale in the transportation of their products. In this case, quality upgrading would result in weaker import competition and actually work against the finding of a positive effect of import competition on quality upgrading. However, the importance of such scale economies in affecting freight rates is unclear. These two possibilities by which quality upgrading could affect transport costs may lead to biases in the estimate of β_{TC} . To help mitigate these potential biases, we follow Bernard et al. (2006a) and include a one-year lag of the variable TC as shown in Equation (1).¹⁰

Second, unit values reflect a combination of quality and cost attributes such as input prices. Specifically, higher costs of production at the plant level may, depending on the market's

⁸ Out of 4,960 country-4-digit industry pairs in Chilean imports, 2,449 (49%) last the entire sample period. Excluding import flows below 5,000 USD, out of 3,866 country-industry pairs, 2,428 (63%) last the entire sample period.

⁹ Considering the top 10 exporting countries to Chile for each 4-digit industry, 4,400 out of 4,764 observations (94%) correspond to relationships that last the entire sample period.

¹⁰ We should note, however, that since unit values are serially correlated over time for plants, the use of lagged transport costs does not fully correct for potential reverse causality.

level of competition, lead to increases in unit values unrelated to quality improvements. Production costs may actually be correlated with our measure of transport costs if intermediate inputs are imported or affected by the degree of import competition in final products. To the extent that transport costs differ across industries in their level and evolution over time and that plants use inputs from industries other than their own, the potential correlation with production costs seems limited. Nevertheless, we believe that our specification must include in the vector of controls proxies for production costs: average wages paid by the plant, the share of skilled labor in the plant's total workforce, unit prices paid for electricity by the plant, and the share of imported materials in total plant materials. Appendix 2 provides details on these four variables.

Third, omitted variables at the industry or plant levels correlated with import competition but also with product quality could bias the estimate of β_{TC} . The knowledge spillovers generated by FDI in an industry could drive plants, particularly those domestic-owned, to upgrade product quality. In this case omitting FDI from our specification could bias downward the effect of import competition. However, higher FDI in an industry could also have a negative effect on quality upgrading by domestic-owned plants through market-stealing effects. In this case omitting FDI from our specification could bias upward the effect of import competition. Import competition may also be correlated with domestic competition in the industry. If stronger domestic competition in an industry has 'escape' effects as in Aghion et al. (2005), then it is likely associated with quality upgrading in that industry. Foreign exporters have an incentive to send to Chile products for which local substitutes have lower quality since it is easier to compete with those. Thus, omitting domestic competition from our specification could result in a negative link between import competition and product quality and a downward bias in the effect of import competition. To control for these possibilities, we include measures of FDI and domestic competition in the vector of controls: the share of total employment in the plant's main 4-digit

industry accounted for by foreign-owned plants and the Herfindahl index for each of the 4-digit industries to which the plant's products belong.¹¹ Foreign-owned plants may produce higher-quality products and exhibit higher unit values relative to domestic-owned plants, regardless of import competition. The vector of controls includes a dummy for the plant's foreign ownership status to account for this possibility. That vector includes also an indicator for multi-product plants to acknowledge potential differences between multi-product and single-product plants.¹²

Fourth, for any given product, quality differences may not fully explain the corresponding dispersion in unit values. Since unit values are prices, their increase may reflect to some extent an increase in a plant's market power. Moreover, plant size may play a role for quality upgrading by allowing the corresponding fixed costs to be spread over a larger scale and granting easier access to the financing necessary for upgrading, mimicking the role that size plays for radical innovation (Cohen, 1995; Cohen and Klepper, 1996). To address these possibilities, the vector of controls includes a measure of the plant's market share in each of the 4-digit industries to which its products belong and three size dummies based on the plant's total employment.¹³

Fifth, economic growth and inflation could affect unit values, hence it is crucial to control for year fixed effects in Equation (1). By also including 3-digit industry-year fixed effects, we account for technological progress or other shocks experienced by Chilean industries during the sample period. In particular, these fixed effects may account for different trends in the prices of

¹¹ Since total employment of a plant is not allocated across the production of each of its products, the share of total employment accounted for by foreign-owned plants is computed for the plant's main 4-digit industry, which is for multi-product plants the industry to which the major product belongs. The major product accounts for the largest share (which could be less than 50%) of the plant's total sales.

¹² For example Bernard et al. (2006b) show that U.S. multi-product plants are significantly larger and more productive than single-product plants. The identification of the coefficient on the indicator for multi-product (*foreign-owned*) plants in our plant fixed effects estimation is based on plants that switch into multi-product status (*foreign ownership*) during the sample period.

¹³ The size dummies are defined in Appendix 2.

materials and capital goods faced by plants operating in different 3-digit industries which could affect the prices at which they sell their final products.¹⁴

Sixth, it is crucial to control for plant-specific unobservable heterogeneity by including plant fixed effects in Equation (1). Plants differ in the diversity of products they manufacture and in the type and quality of management which could affect their incentives and possibilities for quality upgrading. However, due to the presence of multi-product plants in the sample it is also crucial to control for product fixed effects in Equation (1) to ensure that β_{TC} is identified based on a comparison of unit values across plants producing the same product, as import competition changes. Moreover, product fixed effects account for physical or technological characteristics differentiating 7-digit products which may influence their unit values.

In sum Equation (1) allows us to identify an unbiased effect of import competition on product quality upgrading at the plant level due to the exogenous nature of transport costs and the set of control variables and fixed effects included.¹⁵

4. Results

4.1. Main Results

Table 3 presents the results from estimating Equation (1) with robust standard errors clustered by 4-digit industry and year considering all plants and products in Panel A.¹⁶ To

¹⁴ IMF (2008) shows that the recent commodity price boom (with the exception of copper and oil) began only after the end of our sample period. Our year and industry-year fixed effects account for possible increases in the prices of copper and oil in the last two sample years which could have affected final products' unit values. Regarding oil, we also estimate Equation (1) for a sample excluding industries 353 (petroleum refineries) and 354 (manufacture of miscellaneous products of petroleum and coal) and find similar results relative to those discussed in Section 4.1.

¹⁵ Note that active innovation promotion programs may affect plants' incentives and possibilities to engage in quality upgrading. However, our specification would need to account for such programs *only* if they targeted specific industries and could therefore be systematically correlated with import competition. The Chilean National Fund for Technological and Productive Development (FONTEC) - a public program in place since 1991 - helped finance innovation projects for manufacturing firms (Benavente et al., 2007). However, the program did not target specific industries within manufacturing.

¹⁶ The significance of β_{TC} is maintained when standard errors are clustered by plant, product, or product-year.

simplify the interpretation, TC_{it}^{k4} in Equation (1) measures the *negative* of transport costs: i.e., its increase corresponds to an increase in import competition whose quality upgrading impact is captured by a positive β_{TC} . All specifications include plant and product fixed effects, as well as year and 3-digit industry-year fixed effects. The estimates in column (1) show that import competition has a positive effect on product quality when plant cost controls, other plant characteristics, and industry characteristics are ignored. In column (2), the specification includes only plant characteristics in addition to transport costs. The estimate of β_{TC} is positive and significant and its magnitude increases. The difference in results across columns (1) and (2) suggests that in column (1) import competition may be picking up the effect of omitted plant characteristics negatively associated with quality. Columns (3) and (4) show the results from specifications where in addition to transport costs either only industry characteristics or only plant cost controls are included, respectively. The estimates of β_{TC} are positive, significant, and similar in magnitude to that in column (1) suggesting these factors do not substantially affect the results. Column (5) shows our preferred specification which includes the three types of controls.¹⁷ The estimate of β_{TC} implies that a one percentage point reduction in transport costs would lead to an increase in log unit values of almost 2% within plants and products.¹⁸ Since transport costs average 9.2% in our sample, a one percentage point reduction represents a meaningful increase in the degree of import competition faced by plants. Such reduction would correspond to the following important increases in actual unit values: e.g., (i) from an average of

¹⁷ The control variables are contemporaneous relative to plant unit values. However, we obtain qualitatively similar results when one-year lagged control variables are included.

¹⁸ Unit values are measured in logarithms and transport costs are measured in fractional terms, thus 1.9% is obtained by multiplying 1% by 1.887.

USD 86 to USD 93 for bicycles, (ii) from an average of USD 227 to USD 250 for domestic ovens and (iii) from an average of 16,454 USD to USD 19,735 for fabricated motor vehicles.¹⁹

While for brevity the tables do not report the estimated coefficients on the control variables included in our regressions, three findings are noteworthy. For a given product category, larger plants exhibit significantly higher unit values than smaller plants while multi-product plants exhibit significantly lower unit values than single-product plants. Plants with larger market shares have significantly higher unit values, as expected. However, this market power effect does not eclipse the importance of increased import competition in generating quality improvements.

Panels B and C of Table 3 show the results from estimating Equation (1) for two different sub-samples. In Panel B, we use a sub-sample of all plants but only the products that plants neither start producing nor discontinue during their years in the sample (continued products). The effect of import competition on product quality is found to be positive, significant, and much larger than in Panel A. The difference in magnitudes suggests that products with less upgrading potential are likely to be discontinued by plants and new products are also less subject to upgrading as a result of import competition after their initial introduction. In Panel C, we use a sub-sample including only plants that are in the sample during the entire sample period (continuing plants) and including for each of those plants only their continued products. Import competition has a positive and significant effect on product quality, whose magnitude is even larger than in Panel B. This difference in magnitudes suggests that the ‘well-established’ products of continuing plants are more prone to quality upgrading as a response to increased import

¹⁹ These averages are for year 2000 and the unit values are expressed in USD using the corresponding average peso-USD exchange rate obtained from the Central Bank of Chile. Providing an economic magnitude for the average product is difficult due to the lack of comparability of unit values across products measured in different units.

competition than the continued products of plants which just started operations or those of plants in their years shortly before exit.

4.2. Robustness

We conduct an extensive set of robustness tests to our preferred specification (column (5) of Panel A in Table 3).²⁰ First, we consider alternative criteria to eliminate outliers in our dependent variable. Columns (1)-(4) of Table 4 show the estimates of Equation (1) for four samples based on the following outlier criteria: excluding none of the observations (column (1)), excluding the top and bottom 10% of unit values for any product (column (2)), excluding observations with unit values above (below) the 75th (25th) percentile plus (minus) by 1.5 times the inter-quartile range (column (3)) or replacing those observations by those cut-off values (column (4)). The estimates show a significant positive effect of declines in transport costs on quality upgrading.²¹

A possible concern with our estimates is that the regressions give a larger weight to multi-product plants which have more observations per year than to single-product plants. To address this possibility, we follow the two-stage regression procedure proposed by Kugler and Verhoogen (2008). First, we regress plant unit values (the dependent variable in Equation (1)) on plant-year, product-year, and year fixed effects. For any given year, the estimated plant-year fixed effect provides an average plant unit value identified by the differences between a plant's unit value(s) and those of other plants producing the same product(s) in that year. Second, these time-varying average plant unit values are regressed on our transport cost measures along with 3-digit industry-

²⁰ For brevity, we show in what follows only the regression results corresponding to the full sample used in Panel A. However, the pattern detected across panels in Table 3 is also verified for our robustness and other regressions: i.e., the magnitude of β_{TC} is larger for the sub-sample of all plants but only continued products (corresponding to Panel B) and even larger for the sub-sample of continuing plants and continued products (corresponding to Panel C). These results are available from the authors upon request.

²¹ While we base our main results on the exclusion of outliers for product categories, qualitatively similar results are obtained when the exclusion of outliers is done for product-year categories.

year fixed effects.²² In this regression a single-product plant and a multi-product plant included in the sample during the same number of years have equal weight. Column (5) of Table 4 presents the results from this regression and shows that our main finding is qualitatively maintained.

Column (1) of Table 5 shows that the estimate of β_{TC} is robust to the addition of an indicator for the plant's exporter status which controls for possible unit value differences for exporters independent of import competition. Measuring competition in the domestic market is inherently difficult. Column (2) of Table 5 shows that the effect of import competition is robust to the use of the sum of the market shares of the 5 plants with the largest market shares in each of the 4-digit industries to which a plant's products belong as the measure of competition.²³ Moreover, within-country costs of transportation, among several other factors, may give plants in certain regions stronger market power. Hence, we show in column (3) of Table 5 the results from a specification where we add to our preferred specification regional Herfindahl indexes and market shares. Our estimate of β_{TC} remains qualitatively unchanged.

Table 5 also shows the results from three experiments to address potential reverse causality problems in our main specification. A first experiment consists of including in Equation (1) either the two-year or the three-year lag of transport costs. The results reported in columns (4) and (5) still show a positive and significant effect of lagged import competition on quality. A second experiment consists of modifying the definition of transport costs to exclude from the calculation of the weighted average country-product-year freight costs corresponding to import flows below 1,000 or 5,000 USD. The effects of import competition reported in columns (6) and (7) are still positive, significant, and are substantially higher than those in Table 3. This finding is reassuring

²² We refer the reader to Kugler and Verhoogen (2008) for further details on this two-stage procedure, in particular on the non-identification of some plant-year fixed effects.

²³ In unreported regressions we also find robust effects of import competition when we replace the plant's market share in each of its 4-digit industries by that in each of its 5-digit or 6-digit industries, or in each of its 7-digit products. Results are available from the authors upon request.

with respect to the endogeneity concern discussed in Section 3, since import flows above 5,000 USD are more permanent.²⁴ In the third experiment reported in column (8), we find our results to be qualitatively unchanged for an alternative measure based only on the freight rates for country-industry relationships lasting the entire sample period.²⁵ The evidence in columns (6) to (8) suggests that our decision to use information on freight costs for all import flows in our main specification is, if anything, underestimating the effect of import competition on product quality.

4.3. Unit Values and Quality

Increases in unit values seem to correspond well to the definition of incremental innovation in the OECD Oslo manual (1997) which covers “existing product[s] whose performance has been significantly enhanced or upgraded”. For certain consumer products such as automobiles or washing machines, it is clear that higher prices are directly correlated with higher quality. This explains why various studies in the trade literature have taken for granted the idea that increases in export unit values represent improvements in quality (Fontagné and Freudenberg, 1997). The summary statistics on the heterogeneity in unit values presented in Table 1 support this argument. Industries with little scope for quality differences show low relative variation in unit values while industries where quality is expected to play an important role such as professional equipment (which includes information technology products) exhibit a much higher variability in unit values.

An extensive industrial organization literature has examined the role of product pricing as a signal for quality. The market for ‘lemons’ of Akerlof (1970) illustrates this clearly: in the presence of imperfect information, firms with high quality products need to introduce signals -

²⁴ About 63 percent of those country-industry relationships last the entire sample period compared to 49 percent of the country-industry relationships corresponding to all import flows.

²⁵ Note that while the specifications in columns (6) to (8) provide a relevant robustness test, they could introduce a sample selection bias due to the omission of some country-year relationships.

higher prices - to convey to consumers the high quality of their products. Fluet and Garella (2002) show theoretically that in markets with strong vertical product differentiation (i.e., those with substantial quality differences within product categories) firms may base their signaling on prices only.²⁶ Thomas et al. (1998) provide empirical evidence showing that higher prices are used for quality signaling purposes in the U.S. automobile industry. More broadly, this literature shows that prices are a good signal for quality since firms often choose intentionally their level as to reveal to consumers the higher quality of their products.

To provide further support that our estimates refer to product quality, we conduct different tests. Specifically, we examine whether the effects of import competition on unit values are stronger for industries whose product attributes (e.g., substitutability) suggest more opportunities for quality improvements or for plants whose actions or characteristics are likely to be associated with those improvements. We estimate a variant of Equation (1) given by:

$$\log UV_{it}^{p7} = \bar{\beta}_{TC1} * TC_{it-1}^{k4} * group1 + \bar{\beta}_{TCTL} * TC_{it-1}^{k4} * group2 + \gamma * X_{it} + I^{p7} + I_t + I^{m3} * I_t + f_i + \varepsilon_{it}^{p7} \quad (2)$$

where the effect of transport costs is allowed to differ across industries or plants belonging to group 1 and industries or plants belonging to group 2, and all other variables are defined as before. Column (1) of Table 6 reports the results from estimating Equation (2) considering as group 1 (group 2) differentiated goods industries (non-differentiated goods industries) according to the classification proposed by Rauch (1999).²⁷ The response to import competition is expected to be naturally larger in industries with a greater scope for quality differentiation. Our estimates

²⁶ The authors also show that in other scenarios, firms resort additionally to advertising as a signal for quality.

²⁷ According to Rauch's classification, differentiated products are those that are neither (i) homogenous - traded in organized exchanges (e.g., steel) nor (ii) reference-priced - having listed prices in trade publications (e.g., some chemical products) and require a more important degree of buyer-seller interaction. To use Rauch's classification, we establish a correspondence between his 4-digit SITC rev. 2 codes and our 4-digit ISIC rev. 2 codes. For the printing industry (ISIC 342), we are unable to establish an unambiguous correspondence and thus drop it from the regressions using the industry groups 1 and 2 based on the Rauch classification

show that the impact of tougher import competition on quality upgrading is indeed significantly larger for plants in differentiated goods industries.

In addition, product quality upgrading often requires substantial investments in physical capital by plants. Column (2) of Table 6 shows the results from estimating Equation (2) defining group 1 (*group 2*) to include plants engaged in substantial (*low*) new investments relative to their capital stock. We assume that a substantial new investment relative to the capital stock - a ratio above 50% - represents the adoption of new technology by a plant, following Huggett and Ospina (2001). The estimates and the F-test show that the effect of import competition on unit values is significantly stronger for plants engaged in technology adoption.

Moreover, human capital is a key component of a plant's absorptive capacity to new technology and knowledge necessary for product quality upgrading (Cohen and Levintahl, 1989; Pack, 2006). Column (3) of Table 6 shows the results from estimating Equation (2) defining group 1 (*group 2*) to include plants whose wage share of skilled labor in the first sample year is larger (*smaller*) than the sample median. The estimates and the F-test show that increased import competition leads to a significantly stronger increase in unit values for plants with larger skill shares. Overall, the findings in columns (1) to (3) provide evidence to support our assumption that increases in unit values are a good proxy for improvements in product quality.

4.4. The Imports-as-Market-Discipline Hypothesis

A potential concern about our main results arises from the use of product prices as our plant-level outcome of interest. The imports-as-market-discipline hypothesis predicts a negative effect of import competition on price-cost margins (the ratio of the difference between price and marginal cost to price) of manufacturing plants, which might appear to be at odds with our results. To examine the effects of import competition on price-cost margins - which are not

observable given that marginal costs are not observable - we follow the widely used methodology proposed by Roeger (1995). The methodology computes the difference between the primal Solow residual in the presence of imperfect competition (Hall, 1988) and the corresponding dual Solow residual derived from a cost function. This difference eliminates plant unobserved productivity which is associated with an endogeneity bias in production function estimation and results in an equation providing consistent estimates for price-cost margins.²⁸ We allow average price-cost margins to vary with the degree of import competition and with the degree of domestic competition faced by each plant in its main 4-digit industry.²⁹ Our estimable equation is given by:

$$\Delta Z_{it}^{k4} = \beta_1 \Delta X_{it}^{k4} + \beta_2 \Delta X_{it}^{k4} * TC_{it-1}^{k4} + \beta_3 \Delta X_{it}^{k4} * H_{it}^{k4} + \delta_1 TC_{it-1}^{k4} + \delta_2 H_{it}^{k4} + f_i + I_t + \eta_{it} \quad (3)$$

where ΔZ_{it} and ΔX_{it} are computed based on the growth of plant nominal sales, wage bill, intermediate costs, and capital as described in Appendix 3, TC_{it-1}^{k4} is defined as before, H_{it}^{k4} is the Herfindahl index in 4-digit industry $k4$, I_t are year fixed effects, f_i are plant fixed effects, and η_{it} is an i.i.d. residual.³⁰ The estimate of β_1 is the average price-cost margin while the estimates of β_2 and β_3 show how average price-cost margins differ depending on the degree of import and domestic competition, respectively.

The results from estimating Equation (3) by plant fixed effects are shown in Table 7 with standard errors clustered by 4-digit industry and year. Columns (1) and (3) show that the average price-cost margins of Chilean plants are positively related to import competition. However, the effects are insignificant. In contrast, columns (2) and (3) show that average price-cost margins are positively and significantly linked to domestic competition. The estimated positive impact of import competition on price-cost margins may reflect increased market rents achieved by plants

²⁸ We refer the reader to Roeger (1995) and Konings et al. (2005) for details on the derivation of that equation.

²⁹ Plant level estimates of price-cost margins cannot be obtained due to insufficient degrees of freedom.

³⁰ For comparability with the estimates of Equation (1) transport costs are lagged one year. However, the results are qualitatively similar including current transport costs or including all variables lagged one year.

as a result of their incremental innovation to escape increased import competition. Since radical trade liberalization in Chile occurred in the early 1980s, it is not surprising that during our sample period the price-cost margins of Chilean plants were not disciplined by stronger import competition. Those pro-competitive price-lowering effects likely occurred much earlier. However, we should note that the absence of strong effects on price-cost margins does not weaken our evidence of quality upgrading since the increase in price-cost margins driven by higher prices charged for higher quality products may have been counteracted by the higher costs incurred by plants to achieve those quality improvements. If plants have to incur costs to signal the quality of their products, then these additional costs could equally explain why price-cost margins do not vary significantly with import competition.

5. Heterogeneity in the Impact of Import Competition

5.1 Does the Impact Differ by the Type of Exporting Country?

The evidence in Section 4 shows that import competition has on average a positive impact on product quality. A natural question that follows is whether increases in all types of import competition provide Chilean plants with incentives for quality upgrading. One of the advantages of our transport costs measure is that it is based on freight rate information for the countries of origin of all Chilean manufacturing imports. We can therefore distinguish import competition from technologically more advanced, richer, higher-wage countries from import competition from other countries. We estimate the following specification:

$$\log UV_{it}^{p7} = \bar{\beta}_{TCM} * TC_{it-1M}^{k4 \text{ moreadv}} + \bar{\beta}_{TCL} * TC_{it-1L}^{k4 \text{ lessadv}} + \gamma * X_{it} + I^{p7} + I_t + I^{m3} * I_t + f_i + \varepsilon_{it}^{p7}, \quad (4)$$

where transport costs measures are computed separately for more advanced countries

$TC_{it-1M}^{k4 \text{ moreadv}}$ and less advanced countries $TC_{it-1L}^{k4 \text{ lessadv}}$ according to two country classifications,

and all other variables are defined as in Equation (1). First, we define more advanced countries to be high-income and upper-middle income countries according to the World Bank's income group classification and report the results in column (1) of Table 8.³¹ Second, we define more advanced countries to be countries whose scores in the Global Competitiveness Report's general country ranking are above the median score and report the results in column (2) of Table 8.³² The estimates show that increased import competition from less advanced countries is the strongest stimulant for product quality upgrading by Chilean plants. The F-tests show that the difference in the effects across country groups is statistically significant for both classifications. These findings suggest that tougher competition from low-wage countries (including China and India) serves as an incentive for quality upgrading by Chilean plants and thus can be viewed as an advantageous type of competition. The products exported by more advanced countries to Chile may be too sophisticated for local plants to be able to 'beat' through quality upgrading. This finding provides support to the existence of a costly-to-overcome 'technology gap' that Cimoli and Correa (2002) argue has been responsible for lower growth benefits from trade liberalization in Latin America. Our evidence also supports the hypothesis that the high cost of catching-up with more advanced economies in order to upgrade product quality may constitute a barrier to economic growth (Parente and Prescott, 1994).

³¹ We use the World Bank country classification as of April 2007 which establishes four income groups: low-income, lower-middle-income, upper-middle-income and high-income and covers all countries included in our transport cost dataset. The classification is based on gross national income per capita using the World Bank Atlas method. Upper-middle-income and high-income countries have an income level similar to or above that of Chile. We also estimate Equation (4) defining more advanced countries to be high-income countries and obtain qualitatively similar results.

³² The World Global Competitiveness Report (World Economic Forum, 2007) ranks 131 countries' performance based on a broad range of factors affecting a country's business climate: institutions, infrastructure, macroeconomic stability, health and primary education, higher education and training, goods market efficiency, labor market efficiency, financial market, sophistication, technological readiness, market size, business sophistication, and innovation. Countries are ranked and given a performance score. We use the median score to divide our sample into above-median and below-median performers.

5.2. Does the Impact Differ across Types of Plants or Types of Products?

An issue of interest is whether import competition affects product quality across all plants and all products equally or whether the effects are heterogeneous. First, we explore the possibility that plants which are less integrated into global markets may be affected differently by import competition. Table 9 shows the results from estimating Equation (1) based on three restricted subsamples of plants: including only non-exporting plants (column (1)), including only domestic-owned plants (column (2)), and including only domestic-owned plants which do not export (column (3)). The impact of import competition on product quality is positive and significant in all columns. Interestingly, the impact is substantially larger in magnitude for domestic-owned plants that do not export. This means that an increase in import competition elicits the strongest quality upgrading response from the plants that are less exposed to international competition through other channels such as exports or multinational parent linkages. A rationale for this finding is that plants that are more internationally integrated through exports or foreign ownership may already have been forced to undertake quality upgrading and increased import competition provides a weaker incentive for further upgrading.

Second, we examine whether plant size affects the strength of the impact of import competition on product quality. Column (4) of Table 9 shows the results from estimating Equation (2) defining group 1 (*group 2*) to include plants whose average total employment over the sample period is higher (*lower*) than the sample median.³³ Plant size is used as a rough proxy for plant performance and for whether a plant is a ‘leader’ i.e., it is closer to the technological frontier (of its industry or of the world) according to the terminology of Aghion et al. (2005, 2006). However, our F-test shows that the estimated effect of import competition does not differ significantly across plant size. This finding stands in contrast with those of Aghion and co-

³³ The sample median employment is computed pooling across all plants and years. Note that the specifications still include three size dummies as control variables.

authors who show that leaders innovate more due to foreign competition than plants more distant from the technological frontier. The difference in findings could be simply due to the fact that size is a poor proxy for a plant's distance to the technological frontier. Defining the distance to the technological frontier based on plant TFP measures would be closer to the strategy followed by Aghion et al. (2005, 2006) but we deliberately avoid pursuing that strategy due to the presence in our sample of many multi-product plants for which the usual measures of TFP can be biased (Bernard et al., 2005). Instead, we use an indirect approach to estimate heterogeneous impacts. We compute for each 7-digit product and year the absolute coefficient of variation in unit values (a measure of quality dispersion) and regress it on our transport costs measure. The results, reported in column (6) of Table 9, show a positive impact of import competition on product quality dispersion. This finding hints at the presence of heterogeneous impacts of competition on plants, possibly depending on their closeness to the technological frontier. However, the confirmation of this possibility cannot be directly inferred from these results.

Column (5) of Table 9 shows the results from estimating Equation (2) defining group 1 to include products that are exported (at least partially) and group 2 to include products that are sold exclusively in the domestic market. Interestingly, the estimates and F-test show that the impact of increased import competition on quality upgrading is significantly higher for domestically sold products. It is possible that once these domestically sold products achieve sufficiently high quality, plants are able to sell them in export markets also, which is indeed the finding for Mexican plants by Iacovone and Javorcik (2008). This result points to the importance of using data both for domestically sold as well as for exported products to study the link between import competition and quality rather than data on exported products only.

6. Conclusion

So, does import competition affect product quality? We investigate this question using a rich dataset of Chilean plants and products and a regression framework where increases in unit values proxy for product quality improvements and transport costs are the exogenous measure of import competition. Our results show that import competition does have a positive, significant, and robust impact on product quality for Chilean plants. To the extent that these findings can be generalized to other middle-income countries, they suggest that increased exposure to import competition, including that from China and India, can be beneficial by encouraging their producers to follow the “high road” to competitiveness (Pietrobelli and Rabellotti, 2006). Moreover, in light of the evidence provided by Iacovone and Javorcik (2008) that Mexican plants invest in product quality upgrading before they export, our findings suggest that over time plants - including those with no export experience - may be able to progressively target more sophisticated export markets.

However, our evidence also suggests that import competition may be insufficient to enable quality upgrading where the “technology gap” between foreign competitors and local producers is high. In so far as quality upgrading for non-frontier products presents a less demanding task than more radical innovation, our findings suggest that while import competition encourages upgrading, other policy tools will be necessary for more radical innovations.

Our findings also suggest that the recent models of heterogeneous multi-product firms such as those of Bernard et al. (2006c) and Eckel and Neary (2006) that examine changes in firms’ product mix as a response to trade costs’ reductions have yet to exploit other interesting margins of adjustment such as the possibility of quality upgrading.

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Table 1: Heterogeneity in Unit Values within Selected 4-digit Industries

4-digit ISIC		Coefficient of Variation
3111	Slaughtering, preparing and preserving meat	4.6%
3114	Canning, preserving and processing of fish, crustaceans and similar foods	9.7%
3134	Soft drinks and carbonated waters industries	5.0%
3212	Manufacture of made-up textile goods	51.4%
3220	Manufacture of wearing apparel	81.9%
3312	Manufacture of wooden and can containers	37.2%
3420	Printing, publishing and allied industries	30.3%
3530	Petroleum refineries	5.5%
3620	Manufacture of glass and glass products	47.9%
3610	Manufacture of pottery, china and earthenware	22.9%
3692	Manufacture of cement, lime and plaster	7.4%
3831	Manufacture of electrical industrial machinery	34.6%
3844	Manufacture of motorcycles and bicycles	70.5%
3851	Manufacture of professional and scientific, and measuring and controlling equipment n.e.c.	86.6%
3901	Manufacture of jewellery and related articles	28.2%

Notes: The table shows for each 4-digit industry the simple average across all sample years of the industry's yearly coefficients of variation in unit values. For each 4-digit industry and year, the yearly coefficient of variation in unit values is obtained as a weighted average of the coefficients of variation in unit values for each of its 7-digit products using as weights the share of each 7-digit product in the 4-digit industry's total sales in the year.

Table 2: Transport Costs for Selected 4-digit Industries and Years

4-digit ISIC		1997	1999	2002
3112	Manufacture of dairy products	8.0%	6.5%	6.3%
3118	Sugar factories and refineries	10.7%	15.7%	14.0%
3212	Manufacture of made-up textile goods except wearing apparel	6.7%	7.7%	8.6%
3220	Manufacture of wearing apparel except footwear	5.0%	5.4%	5.1%
3312	Manufacture of wooden and cane containers and small cane ware	9.1%	6.3%	6.1%
3320	Manufacture of furniture and fixtures, except primarily of metal	13.7%	12.2%	14.0%
3122	Manufacture of prepared animal feeds	15.6%	12.9%	12.7%
3133	Malt liquors and malt	19.5%	12.6%	15.7%
3140	Tobacco manufactures	8.2%	8.5%	8.8%
3215	Cordage, rope and twine industries	4.3%	5.1%	6.4%
3233	Manufacture of leather and leather substitutes, except footwear and wearing apparel	8.3%	9.8%	9.1%
3240	Manufacture of footwear, except vulcanised or moulded rubber and plastic footwear	5.2%	5.5%	5.8%
3412	Manufacture of containers and boxes of paper and paperboard	15.1%	10.5%	10.4%
3512	Manufacture of fertilizers and pesticides	11.2%	11.9%	11.0%
3551	Tyre and tube industries	8.0%	7.7%	8.3%
3560	Manufacture of plastic products not elsewhere specified	10.3%	10.0%	9.1%
3620	Manufacture of glass and glass products	13.5%	14.3%	13.8%
3720	Non-ferrous metal basic industries	4.6%	4.6%	4.1%
3822	Manufacture of agricultural machinery and equipment	6.5%	5.4%	6.2%
3831	Manufacture of electrical industrial machinery and apparatus	4.9%	4.6%	4.8%
3852	Manufacture of photographic and optical goods	3.4%	3.4%	3.8%
3420	Printing, publishing and allied industries	8.0%	8.7%	8.2%
3522	Manufacture of drugs and medicines	3.3%	3.1%	3.3%
3610	Manufacture of pottery, china and earthenware	11.9%	15.7%	14.0%
3710	Iron and steel basic industries	10.6%	10.1%	10.1%
3812	Manufacture of furniture and fixtures primarily of metal	12.2%	11.4%	12.9%
3813	Manufacture of structural metal products	9.8%	7.7%	8.0%
3844	Manufacture of motorcycles and bicycles	8.7%	10.6%	11.5%

Note: The table shows for each 4-digit industry transport costs aggregated from the level of the 8-digit HS code, exporting country, and year to the level of the 4-digit ISIC and year using as weights Chile's fob imports from each country and year.

Table 3: Effects of Transport Costs on Unit Values – Main Results

Panel A: Full Sample

<i>Dependent Variable: Log of Unit Value</i>					
	(1)	(2)	(3)	(4)	(5)
Transport Costs t-1	1.887** (0.750)	1.891** (0.750)	1.884** (0.740)	1.881** (0.750)	1.887** (0.730)
Plant Controls	No	Yes	No	No	Yes
Industry Controls	No	No	Yes	No	Yes
Plant Cost Controls	No	No	No	Yes	Yes
Product Fixed Effects	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
3-Digit Industry*Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Number of Observations	41032	41032	41018	40991	40981
R-Squared	0.56	0.56	0.56	0.56	0.56

Panel B: Sample of Continued Products

<i>Dependent Variable: Log of Unit Value</i>					
	(1)	(2)	(3)	(4)	(5)
Transport Costs t-1	3.897*** (0.950)	3.875*** (0.960)	3.788*** (0.920)	3.904*** (0.950)	3.788*** (0.930)
Plant Controls	No	Yes	No	No	Yes
Industry Controls	No	No	Yes	No	Yes
Plant Cost Controls	No	No	No	Yes	Yes
Product Fixed Effects	Yes	Yes	Yes	Yes	Yes
Plant Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
3-Digit Industry*Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Number of Observations	18159	18159	18156	18138	18138
R-Squared	0.57	0.57	0.57	0.57	0.58

Panel C: Sample of Continuing Plants and Continued Products

<i>Dependent Variable: Log of Unit Value</i>					
	(1)	(2)	(3)	(4)	(5)
Transport Costs t-1	4.691*** (0.980)	4.639*** (0.990)	4.516*** (0.930)	4.680*** (0.980)	4.463*** (0.940)
Plant Controls	No	Yes	No	No	Yes
Industry Controls	No	No	Yes	No	Yes
Plant Cost Controls	No	No	No	Yes	Yes
Product Fixed Effects	Yes	Yes	Yes	Yes	Yes
Plant Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
3-Digit Industry*Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Number of Observations	11762	11762	11762	11750	11750
R-Squared	0.59	0.59	0.59	0.59	0.59

Notes: Robust standard errors clustered by 4-digit industry and year in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. The negative of transport costs is included in the regressions. Plant controls include size dummies, a dummy for foreign ownership, a dummy for multi-product plants, and the plant's market share at the 4-digit level. Industry controls include the share of employment in foreign-owned plants in total 4-digit industry employment and the normalized Herfindahl index at the 4-digit industry level. Plant cost controls include the log of average wages, the share of skilled labor in total labor, the log of unit electricity prices paid by the plant, and the share of imported inputs in total inputs. The regressions in Panel B are estimated for the sub-sample of all plants but only products that the plant neither starts producing nor discontinues during its years in the sample while those in Panel C are estimated for the sub-sample of plants included in the sample during the entire sample period and for each of those plants only the products that they produce during the entire sample period.

Table 4: Effects of Transport Costs on Unit Values – Different Outlier Criteria and Weights

	Dependent Variable: Log of Unit Value				Dependent Variable: Residual Log of Unit Value
	Different Outlier Criteria for Unit Values				
	No Outliers Excluded	Exclude Top/Bottom 10% of Unit Values by Product	Exclude Unit Values Based on Quartiles Criterion by Product	Windsorize Unit Values Based on Quartiles Criterion by Product	Second Stage Regression in 2-Stage Procedure
	(1)	(2)	(3)	(4)	(5)
Transport Costs _{t-1}	1.917** (0.840)	1.821** (0.730)	1.745** (0.730)	2.156*** (0.760)	5.119*** (1.880)
Plant Controls	Yes	Yes	Yes	Yes	No
Industry Controls	Yes	Yes	Yes	Yes	No
Plant Cost Controls	Yes	Yes	Yes	Yes	No
Product Fixed Effects	Yes	Yes	Yes	Yes	No
Plant Fixed Effects	Yes	Yes	Yes	Yes	No
Year Fixed Effects	Yes	Yes	Yes	Yes	No
3-Digit Industry*Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Number of Observations	44157	36733	41929	44157	19546
R-Squared	0.50	0.59	0.58	0.57	0.32

Notes: Robust standard errors clustered by 4-digit industry and year in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. The negative of transport costs is included in the regressions. The samples used in columns (1) to (4) are described in the text. Plant controls in columns (1)–(4) include size dummies, a dummy for foreign ownership, a dummy for multi-product plants, and the plant's market share at the 4-digit level. Industry controls include the share of employment in foreign-owned plants in total 4-digit industry employment and the normalized Herfindahl index at the 4-digit industry level. Plant cost controls include the log of average wages, the share of skilled labor in total labor, the log of unit electricity prices paid by the plant, and the share of imported inputs in total inputs.

Table 5: Effects of Transport Costs on Unit Values – Robustness

	Dependent Variable: Log of Unit Value							
	Additional Plant Control	Different Competition Measure		Alternative Lags for Transport Costs Measure		Alternative Transport Costs Measures		
	Exporter Status	Share of Top 5 Plants in 4-digit Industry	Adding Regional Competition Measures	Two-Year Lag	Three-Year Lag	Exclude Country-Product Import Flows below USD 1,000	Exclude Country-Product Import Flows below USD 5,000	Include Only Continued Country-4-digit Industry Import Flows
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Transport Costs $t-1$	1.888** (0.730)	1.955** (0.770)	2.601*** (0.780)			3.336*** (1.180)	3.255*** (1.170)	3.937*** (1.250)
Transport Costs $t-2$				2.683** (1.330)				
Transport Costs $t-3$					2.765* (1.440)			
Plant Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant Cost Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3-Digit Industry*Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	40981	40734	38276	32387	24368	40947	40947	40834
R-Squared	0.56	0.56	0.57	0.56	0.57	0.56	0.56	0.56

Notes: Robust standard errors clustered by 4-digit industry and year in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. All regressions include the negative of transport costs, those in columns (6) to (8) include modified versions of that measure described in the text. Plant controls include size dummies, a dummy for foreign ownership, a dummy for multi-product plants, and the plant's market share at the 4-digit level., and a dummy for the plant's exporter status (only in column (1)). Industry controls include the share of employment in foreign-owned plants in total 4-digit industry employment and the normalized Herfindahl index at the 4-digit industry level (except in column (2) where the sales share of the largest 5 plants at the 4-digit level is included). Plant cost controls include the log of average wages, the share of skilled labor in total labor, the log of unit electricity prices paid by the plant, and the share of imported inputs in total inputs.

Table 6: Effects of Transport Costs on Unit Values – Evidence of Quality Upgrading

	Dependent Variable: Log of Unit Value		
	(1)	(2)	(3)
Transport Costs $t-1$ * Dummy for Differentiated Product Industries	5.386*** (1.880)		
Transport Costs $t-1$ * Dummy for Non-Differentiated Product Industries	1.304* (0.760)		
Transport Costs $t-1$ * Dummy for Large Investment-Capital Ratio		2.591*** (0.860)	
Transport Costs $t-1$ * Dummy for Small Investment-Capital Ratio		1.698** (0.700)	
Transport Costs $t-1$ * Dummy for Firms with Higher Skilled Share			2.702*** (0.710)
Transport Costs $t-1$ * Dummy for Firms with Lower Skilled Share			1.740** (0.820)
Plant Controls	Yes	Yes	Yes
Industry Controls	Yes	Yes	Yes
Plant Cost Controls	Yes	Yes	Yes
Product Fixed Effects	Yes	Yes	Yes
Plant Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
3-Digit Industry*Year Fixed Effects	Yes	Yes	Yes
P-value for F-Test of Difference in Coefficients across Groups	0.04	0.04	0.08
Number of Observations	39296	40981	37343
R-Squared	0.56	0.56	0.57

Notes: Robust standard errors clustered by 4-digit industry and year in parentheses. **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. The regressions include the negative of transport costs interacted with alternative sets of dummy variables described in the text. The plant controls, industry controls, and plant cost controls included in the regressions are similar to those in column (5) of Panel A of Table 3.

Table 7: Effects of Transport Costs on Price-Cost Margins

<i>Dependent Variable: ΔZ_{it} (in Equation (3))</i>			
	(1)	(2)	(3)
ΔX_{it}	0.506*** (0.029)	0.454*** (0.016)	0.492*** (0.029)
$\Delta X_{it} * \text{Transport Costs}_{t-1}$	0.417 (0.340)		0.413 (0.324)
$\Delta X_{it} * \text{Herfindahl Index}_{it}$		0.178** (0.084)	0.177** (0.081)
Plant Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Number of Observations	18282	18282	18265
R-Squared	0.42	0.42	0.42

Notes: Robust standard errors clustered by 4-digit industry and year in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. The computation of the dependent variable ΔZ_{it} and of ΔX_{it} is described in Appendix 3. In columns (1) and (3) the negative of transport costs is included in levels and interacted with ΔX_{it} .

Table 8: Effects of Transport Costs on Unit Values – By Type of Country

<i>Dependent Variable: Log of Unit Value</i>		
	(1)	(2)
Transport Costs $t-1$ from More Advanced Countries WB	0.639 (0.720)	
Transport Costs $t-1$ from Less Advanced Countries WB	3.381*** (0.900)	
Transport Costs $t-1$ from More Advanced Countries GCR		-0.273 (0.670)
Transport Costs $t-1$ from Less Advanced Countries GCR		3.362*** (1.030)
Plant Controls	Yes	Yes
Industry Controls	Yes	Yes
Plant Cost Controls	Yes	Yes
Product Fixed Effects	Yes	Yes
Plant Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
3-Digit Industry*Year Fixed Effects	Yes	Yes
P-value for F-Test of Difference in Coefficients across Country Groups	0	0
Number of Observations	40947	40907
R-Squared	0.56	0.56

Notes: Robust standard errors clustered by 4-digit industry and year in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. Column (1) includes the negative of transport costs for high income and upper-middle income countries and for lower-middle income and low income countries according to the World Bank country specification. Column (2) includes the negative of transport costs for countries with a performance score above the median and for countries with a performance score below the median, according to the Global Competitiveness Report. The plant controls, industry controls, and plant cost controls included in the regressions are similar to those in column (5) of Panel A of Table 3.

Table 9: Effects of Transport Costs on Unit Values – By Type of Plant or Product

Dependent Variable: Log of Unit Value						Dependent Variable is Coefficient of Variation in Unit Values
Excluding Plants with International Ties						
	Sample of Non- Exporting Plants	Sample of Domestic Plants	Sample of Domestic Non- Exporting Plants			
	(1)	(2)	(3)	(4)	(5)	(6)
Transport Costs $t-1$	3.529*** (0.850)	1.924** (0.760)	3.784*** (0.900)			0.617*** (0.140)
Transport Costs $t-1$ * Smaller Plants Dummy				1.681*** (0.640)		
Transport Costs $t-1$ * Larger Plants Dummy				1.506** (0.690)		
Transport Costs $t-1$ * Exported Products Dummy					0.887 (0.780)	
Transport Costs $t-1$ * Non-Exported Products Dummy					2.089*** (0.730)	
Plant Controls	Yes	Yes	Yes	Yes	Yes	No
Industry Controls	Yes	Yes	Yes	Yes	Yes	Yes
Product Cost Controls	Yes	Yes	Yes	Yes	Yes	No
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	No
Product Fixed Effects	Yes	Yes	Yes	Yes	Yes	No
Plant Fixed Effects	Yes	Yes	Yes	Yes	Yes	No
3-Digit Industry*Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
P-value for F-Test of Difference in Coefficients across Groups				0.61	0	
Number of Observations	31309	38500	30411	40981	40981	3737
R-Squared	0.6	0.57	0.6	0.56	0.56	0.14

Notes: Robust standard errors clustered by 4-digit industry and year in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. All regressions include the negative of transport costs, those in columns (4) and (5) include that variable interacted with alternative sets of dummy variables described in the text. The plant controls, industry controls, and plant cost controls included in the regressions are similar to those in column (5) of Panel A of Table 3.

Appendix

Appendix 1: Examples of 7-Digit Products for Selected 4-digit Industries

4-digit ISIC		7-digit ISIC	Product Description	Unit of Measurement	Average Annual Unit Value Changes
3117	Manufacture of bakery products	3117101	Bread of any kind, size and quality (except sweet bread)	in tons	2.89%
		3117201	Cookies, with and without sugar and filled	in tons	4.28%
		3117301	Noodles, pasta including macaroni	in tons	0.22%
		3117402	Mixed dough (for different types of cakes)	in tons	-11.42%
		3311307	Finished parquet excluding plastic parquet	in square meters	1.28%
3311	Sawmills, planing and other wood mills	3311302	Wooden boards for prefabricated houses	in square meters	-13.16%
		3311306	Wooden doors with or without glass	in units	0.10%
		3311124	Sawing wood	in cubic meters	5.94%
3320	Manufacture of furniture and fixtures, except primarily of metal	3320908	Sofas and armchairs of the type used in ceremonies	in units	31.79%
		3320910	Wooden tables for computers and typewriters	in units	10.08%
		3320906	Wooden household furniture	in units	26.47%
		3320913	Office furniture	in units	-5.45%
3483	Manufacture of motor vehicles	3843201	Fabricated motor vehicles	in units	0.41%
		3843409	Wheels and related parts and vehicle accessories	in units	5.78%
		3843421	Heating appliances for motor vehicles	in units	-2.68%
		3843422	Metallic frames for trucks, special frames	in units	19.27%
3559	Manufacture of rubber products n.e.c.	3559324	Gloves of caoutchouc	one pair	13.63%
		3559327	Sports shoes	one pair	5.51%
		3559320	Caoutchouc sheathing for mining	in tons	17.00%
		3559332	Articles made of caoutchouc for vehicles	in tons	26.81%
3829	Machinery and equipment except electrical n.e.c.	3829056	Cablecars	in units	20.74%
		3829032	Gas regulators	in units	-4.56%
		3829060	Moving staircases	in units	26.01%
		3829002	Pumps for liquids for manual use	in units	13.71%

Notes: For each 7-digit product and year, we compute the average logarithmic unit value by pooling across all plants that manufacture that product. Then across any two consecutive years we compute the difference in average log unit values to obtain the annual change in unit values. The statistic in the table shows the simple average of those annual changes.

Appendix 2: Data Issues

Appendix 2.1: Plant and Products Data

We combine a products dataset at the 7-digit level for the period 1997-2003 and the annual manufacturing census of Chilean plants with more than 10 employees (ENIA) for the same period. As described in Fernandes and Paunov (2008) the ENIA includes some plants with discontinuous data over the sample period. For those plants, we consider only the observations across consecutive years for which yearly growth rates of any variable can be computed. In the products dataset, products are identified by a classification based on ISIC Rev. 2 and Rev. 3. More detail on the products data is provided in Navarro (2008). We obtain products at the 7-digit level building up from what Navarro (2008) refers to as ‘ENIA products’. Specifically, for each plant reporting more than one entry for a 7-digit product in a given year (Z entries) we sum the information on sales values and product quantities of those Z entries for that plant as long as all the Z entries’ quantities are reported in the same unit. The sum provides us with a single entry for that 7-digit product for that plant in that year. If the entries’ quantities are reported in multiple units, we drop those products from the analysis. Note that these deletions occur in a very small number of cases. Also note that if aggregated to the 4-digit level, our 7-digit products correspond exactly to the United Nations product classification.

For our analysis, we use information on sales values and product quantities sold for each 7-digit product, plant, and year. We exclude from the final sample (i) plants that do not report the measurement unit for their products’ quantities and (ii) plants that report their products’ quantities in a different unit than the unit in which the majority of plants report. We also exclude

from the sample the top and bottom 5% of the unit values' distribution for any 7-digit product. After applying these data cleaning procedures our final sample includes 55,294 plant-year-product observations.

We test the goodness of our products data by identifying plants with irregular product 'drops' (i.e., products that disappear from production and then reappear again) and plants with product 'jumps' (i.e., products that are produced only once in the intermediate years of plant presence in the sample). These tests, which follow Bernard et al. (2008), are satisfactory in that product 'drops' and product 'jumps' are relatively infrequent. We also perform another test which compares the standard deviations of 'purged' unit values for 4-digit industries with the same standard deviations obtained for a Colombian products dataset by Kugler and Verhoogen (2008). 'Purged unit values' are the residuals from regressions of log unit values on product fixed effects or from regressions of log unit values on product-year fixed effects. Our standard deviations are somewhat larger than theirs but are sufficiently within bounds to be explained by the fact that we consider a different country with a distinct profile of manufacturing production.

We use variables from the ENIA census to compute the proxies for costs of production included in our regressions. Plant average wages are obtained as the ratio of total wages paid to the plant's employees. Plant skill share is defined as the ratio of the number of skilled workers (a sum of managers, administrative personnel and qualified production workers) to the total number of workers employed by the plant. Plant electricity unit prices are computed as the log of the ratio of electricity expenditure to the quantity of electricity purchased. To eliminate outliers in each of these variables, we follow a 'winsorizing' procedure whereby we replace the top and bottom 5th percentile of observations in each year by the value of the cut-off observations at the 5th and 95th percentile in that year, respectively. Plant share of imported materials is computed as the ratio of the expenditure in imported materials and primary inputs to the overall expenditure in materials and primary inputs. The three size dummies are defined based on total employment: small plants have less than 50 employees, medium plants have 50 to 200 employees, and large plants have more than 200 employees.

Appendix 2.2: Transport Costs Data

We use a transport costs dataset from the ALADI secretariat for the period 1997-2003 that includes the freight value (excluding insurance costs) and the free on board customs value (fob) of Chilean imports for each 8 digit HS code, exporting country, and year. For each 8-digit HS code, exporting country, and year we compute a freight rate as the ratio of the freight costs to the fob imports. We remove observations with higher freight costs than their fob import value for values below 1,000 USD. Our measure of transport costs is given by a weighted average of the freight rate aggregated from the level of the 8-digit HS code, exporting country, and year, to the level of the 4-digit ISIC and year using as weights Chile's fob imports from each country and year. To convert import flows between 8-digit HS codes and 4-digit ISIC codes we use a correspondence obtained from <http://www.maclester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/TradeConcordances.html>. Our dataset includes all Chilean imports originating in 169 countries. Taking the overall value of imports for the entire period 1997-2003, the top 10 exporters to Chile are the United States, Brazil, Argentina, China, Germany, Japan, France, Mexico, South Korea, and Italy.

Appendix 3: Methodology and Data Issues for Price-Cost Margins

The difference between the primal Solow residual and the corresponding dual Solow residual derived from a cost function results in the equation below which follows Konings et al. (2005):

$$\begin{aligned} & \left(\frac{\Delta Y_{it}}{Y_{it}} + \frac{\Delta P_{Y_{it}}}{P_{Y_{it}}} \right) - \alpha_{Lit} \left(\frac{\Delta L_{it}}{L_{it}} + \frac{\Delta P_{L_{it}}}{P_{L_{it}}} \right) - \alpha_{Mit} \left(\frac{\Delta M_{it}}{M_{it}} + \frac{\Delta P_{M_{it}}}{P_{M_{it}}} \right) - (1 - \alpha_{Lit} - \alpha_{Mit}) \left(\frac{\Delta K_{it}}{K_{it}} + \frac{\Delta P_{K_{it}}}{P_{K_{it}}} \right) \\ & = \beta_{it} \left[\left(\frac{\Delta Y_{it}}{Y_{it}} + \frac{\Delta P_{Y_{it}}}{P_{Y_{it}}} \right) - \left(\frac{\Delta K_{it}}{K_{it}} + \frac{\Delta P_{K_{it}}}{P_{K_{it}}} \right) \right] \end{aligned} \quad (A1)$$

where β_{it} is the price-cost margin for plant i in year t , $(\Delta Y_{it}/Y_{it} + \Delta P_{Y_{it}}/P_{Y_{it}})$ is nominal sales growth, $(\Delta L_{it}/L_{it} + \Delta P_{L_{it}}/P_{L_{it}})$ is wage bill growth, $(\Delta M_{it}/M_{it} + \Delta P_{M_{it}}/P_{M_{it}})$ is intermediate costs growth, $(\Delta K_{it}/K_{it} + \Delta P_{K_{it}}/P_{K_{it}})$ is capital stock growth, and α_{Lit} , α_{Mit} are labor and intermediates shares in total nominal sales. Equation (A1) assumes constant returns to scale: $(1 - \alpha_{Lit} - \alpha_{Mit})$ is the cost share of capital. To reach Equation (2) in the text we designate the left hand side of Equation (A1) by ΔZ_{it} , and the right hand side parentheses term by ΔX_{it} , we interact ΔX_{it} separately with the transport costs measure and with the Herfindahl index, we include in Equation (A1) the transport costs measure and the Herfindahl index levels as well as year fixed effects and we add an i.i.d. stochastic residual η_{it} . Equation (2) in the text is estimated for the sample of plants in the ENIA dataset during the 1997-2003 period. For plants with discontinuous data we include only the observations across consecutive years for which yearly growth rates of variables can be computed. The sample differs from that used for the unit values regressions since the observations are dropped based on the following criteria: (1) we exclude from the sample plants with missing sales, wage bill, intermediate costs, or capital variables; (2) we impute sales, wage bill, intermediate costs, or capital to correct for non-reporting by a plant in a single year (which occurs in fewer than 30 plant-year observations); (3) we exclude from the sample plants whose sales growth, wage bill growth, or capital growth is larger than (smaller than) 400%; (4) we exclude from the sample plants whose sales (wage bill) growth ranges between 100% and 300% (-300% and -100%) but is not accompanied by corresponding high (low) growth rates of intermediate costs (total employment). After applying these data cleaning procedures our final sample includes 31,318 plant-year observations.

To compute ΔZ_{it} and ΔX_{it} , we use plant-level information on nominal sales and on total wage bill and compute their corresponding logarithmic growth rates. Nominal intermediate costs are obtained as the sum of materials costs and electricity costs and the corresponding logarithmic growth rate is calculated. Capital stocks are computed using the perpetual inventory method (PIM) as described in Fernandes and Paunov (2008) and the corresponding logarithmic growth rate is computed. We define the rental price of capital to be equal to the product of the aforementioned investment goods price deflator and the sum of the real interest rate and a depreciation rate as in Konings et al. (2005). Similarly, data on the lending interest rate and the consumer price index taken from the IMF financial statistics is used to compute the real interest rate. The depreciation rate used is the simple average of the rates used by Fernandes and Paunov (2008) for three types of capital goods: 3% for buildings, 7% for machinery and equipment, and 11.9% for transport equipment. Using an alternative depreciation rate equal to 10% provides almost similar results. The share of labor (*intermediates*) in sales is given by the ratio of the wage bill (*intermediate costs*) to total nominal sales.